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ABSTRACT

Focusing on structural construction occupations, this document is one in a series of forty-one reprints from the Occupational Outlook Handbook providing current information and employment projections for individual occupations and industries through 1985. The specific occupations covered in this document include bricklayers, stonemasons, marble setters, carpenters, cement masons, terrazzo workers, construction laborers, elevator constructors, ironworkers, operating engineers (construction machinery operators), plumbers, pipefitters, and roofers. The following information is presented for each occupation or occupational area: a code number referenced to the Dictionary of Occupational Titles; a description of the nature of the work; places of employment; training, other qualifications, and advancement; employment outlook; earnings and working conditions; and sources of additional information. In addition to the forty-one reprints covering individual occupations or occupational areas (CE 017 757-797), a companion document (CE 017 756) presents employment projections for the total labor market and discusses the relationship between job prospects and education. (BM)

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ED158118

Construction Occupations -- Structural

Reprinted from the
Occupational Outlook Handbook,
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CE 017 768

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Containing the midpoints of the legs of right triangle RST, whe pt. $(-5, 5)$, S is pt. $(1, 1)$, and T is pt. $(3, 4)$.

Containing the longer diagonal of a quadrilateral whose verti pts. $(2, 2)$, $(-2, -2)$, $(1, -1)$, and $(6, 4)$.

Show that the equations $y - 1 = \frac{1}{2}(x + 3)$ and $y - 4 = \frac{1}{2}($ are equivalent.

An equation of the line containing pts. $(-2, 3)$ and $(4, -)$ written in the form $y - 3 = -\frac{1}{2}(x + 2)$ or in the $y + 1 = -\frac{1}{2}(x - 4)$, depending upon which point you take (x_1, y_1). Show that the two equations are equivalent.

Show that the equations are equivalent.

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1) \qquad y - y_2 = \frac{y_1 - y_2}{x_1 - x_2}(x -$$

State the equation of a line through pt. (p, q) and parallel to containing pts. (a, b) and (c, d). $(a \neq c)$.

BRICKLAYERS, STONEMASONS, AND MARBLE SETTERS

(D.O.T. 861.381 and .781)

Nature of the Work

Bricklayers, stonemasons, and marble setters work in closely related trades, each producing attractive, durable surfaces. Bricklayers build walls, partitions, fireplaces, and other structures with brick, cinder block, and other masonry materials. They also install firebrick linings in industrial furnaces.

Stonemasons build stone walls as well as set stone exteriors and floors. They work with two types of stone—natural cut, such as marble, granite, and limestone; and artificial stone made from cement, marble chips, or other masonry materials. Because stone is expensive, stonemasons work mostly on high-cost buildings, such as offices, hotels, and churches.

Marble setters install marble which provides very decorative and highly durable surfaces. Marble setters, like stonemasons, work mostly on high-cost buildings. The marble they use usually is cut and polished before it is sent to the job site.

In putting up a wall, bricklayers first build the corners at each end of the wall, using plumblines and a level. A line then is stretched from corner to corner as a guide for each course or layer of brick. Bricklayers spread a bed of mortar (cement mixture) with a trowel (a flat metal tool), place the brick on the mortar bed, and then tap it into place. As blueprints specify, they cut bricks with a hammer and chisel to fit around windows, doors, and other openings. Mortar joints are finished with jointing tools to leave a neat and uniform appearance. Bricklayers also may weld metal supports for bricks.

Bricklayers are assisted by hod carriers, or helpers, who supply them with bricks and other materials, mix mortar, and set up and move scaffolding. (See the statement on construction laborers that appears elsewhere in the *Handbook*.)

Stonemasons often work from a set of drawings in which each stone has been numbered for identification. Helpers may locate and bring the prenumbered stones to the masons. A derrick operator using a hoist may be needed to lift large pieces into place.

When building a stone wall, masons set the first layer of stones into a shallow bed of mortar. They align the stones with plumblines and levels, and tap them into position with a wood mallet. Masons build the wall by alternating layers of mortar and stone. As the work progresses, they fill the joints between stones with mortar using a pointed metal tool to smooth the mortar to an attractive finish. To hold stones in place, stonemasons sometimes position pieces of metal within the wall by welding or bolting them together. After positioning the rocks, they cover the metal with mortar. Finally, for a clean appearance, masons wash the stone with a mild acid solution to remove dirt and dry mortar.

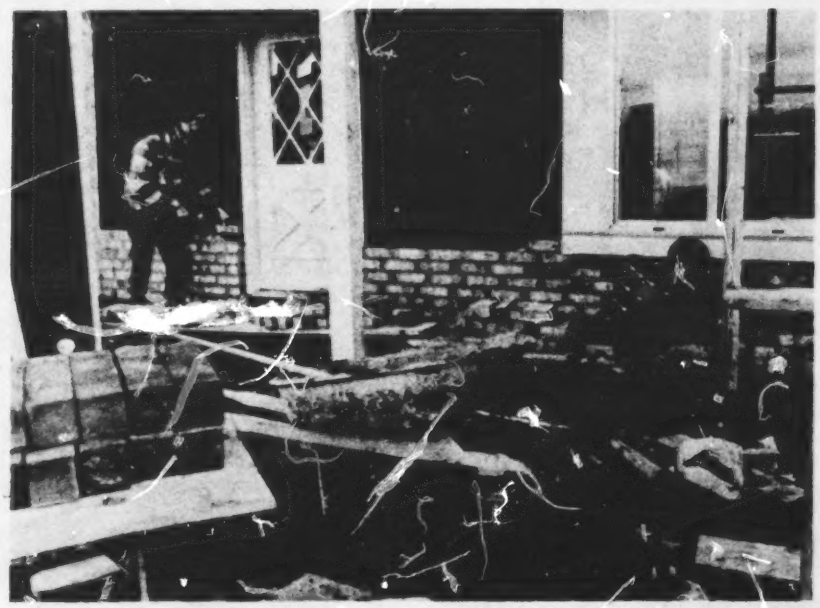
When setting stone floors, masons trowel a thin layer of mortar over the surface. They then hand set the stone in the mortar, leaving the surface of the stone exposed. To finish, workers trowel the joints and wash the stone.

To cut stone into various shapes and sizes, masons find the grain of each piece of stone and use a special hammer to strike it along a predetermined line. Valuable pieces often are cut with a saw that has a special blade.

Setting marble is very much like setting stone. Marble setters prepare a fine mixture of cement, sand, and water—called mortar—then trowel a thin layer of it onto the surface. For floors and for walls where the holding strength of mortar alone is sufficient, setters—following instructions from blueprints—often hand set each marble piece into the mortar, leaving the face of the marble exposed. For heavy pieces, workers employ a hoist to lift and position the marble. To secure heavy pieces on walls, setters use bolts in addition to mortar. Once the marble pieces are positioned and secured, setters mortar and trowel the joints and clean the marble's surface.

In addition to construction work, marble setters do repair work. They fill and cover holes and cracks in marble with mortar prepared and finished to look like the marble. They also polish and replace marble. When pieces are too large, setters cut them to size using a special saw.

Bricklayers, stonemasons, and marble setters primarily use handtools—including trowels, brick and stone hammers, wood or rubber



About 1 out of 7 bricklayers, stonemasons, and marble setters is self-employed.

mallets, and chisels. For exacting cuts of brick, stone, or marble, they use high-powered electric saws equipped with special cutting blades.

Places of Employment

About 175,000 bricklayers, stonemasons, and marble setters were employed in 1976; most were bricklayers. Workers in these crafts were employed primarily by special trade, building, or general contractors. A relatively small number of bricklayers work for government agencies or businesses that do their own construction and alteration.

Workers in these trades are employed throughout the country, but are concentrated in metropolitan areas. In cities that are too small to have a demand for full-time stonemasons or marble setters, bricklayers will install stone or marble as a sideline.

About 1 out of 7 bricklayers, stonemasons, and marble setters is self-employed—a proportion higher than that in most building crafts. Many of the self-employed specialize in contracting on small jobs such as patios, walks, and fireplaces.

Training, Other Qualifications, and Advancement

Most bricklayers as well as some stonemasons and marble setters pick up their skills informally by working as helpers or hod carriers and by observing and learning from experienced workers. The remainder learn their skills through apprenticeship, which provides the most thorough training.

Individuals who learn the trade informally usually become bricklayers. They start with carrying materials, moving scaffolds, and mixing mortar. However, it takes several months to a year before they are taught to spread mortar and lay brick. They begin with simple patterns and progress to more complex designs. Learning to set stone or marble might take several years.

Apprenticeships for bricklayers, stonemasons, and marble setters usually are sponsored by local union-management committees. The apprenticeship program requires 3 years of on-the-job training, in addition to 144 hours of classroom instruction each year in subjects such as blueprint reading, mathematics, layout work, and sketching. Apprentices learn the general applications of brick, stone, and marble.

Apprentices start by carrying materials and mixing mortar. Within 2 or 3 months, they learn to align, lay, and clean brick. Apprentices eventually learn to work with stone and marble. After apprenticeship, they usually specialize in one of the three trades.

Applicants for apprenticeships must be at least 17 years old. Apprentice and helper applicants should be in good physical condition. A high school or vocational school education is preferable, as are courses in mathematics, mechanical drawing, and shop.

Experienced workers can advance to supervisory positions or become estimators. They also can open contracting businesses of their own.

Employment Outlook

Employment of bricklayers is expected to increase about as fast as the average for all occupations through the mid-1980's. In addition to the job openings that result from employment growth, many openings will arise as experienced bricklayers retire, die, or leave the occupation for other reasons.

As population and business growth create a need for new homes, factories, offices, and other structures, the demand for bricklayers will grow. Stimulating this growth will be the increasing use of brick for decorative work on building fronts and in lobbies and foyers. The use of brick, particularly for interior load-bearing walls, is growing and will add to overall employment needs.

Over the long run, job openings for bricklayers are expected to be plentiful; however the number of openings may fluctuate from year to year because employment in this trade is sensitive to ups and downs in construction activity. For any given year, opportunities usually are best during the spring and summer when construction activity picks up.

Employment of stonemasons and marble setters is not expected to change significantly through the mid-1980's. Stone and marble have lost popularity as building materials because they have become much more expensive than materials such as brick and concrete. Nevertheless, a small number of jobs will become available due to the need to replace stonemasons and marble setters who retire, die, or leave the occupations.

Earnings and Working Conditions

Hourly wage rates were $9.90 for bricklayers, $10.05 for stonemasons, and $9.60 for marble setters, according to a 1976 survey of union wage rates in metropolitan areas. These rates are about twice the average wage of nonsupervisory and production workers in private industry, except farming. However, yearly earnings for workers in these trades generally are lower than hourly rates would indicate because the annual number of hours they work can be adversely affected by poor weather and fluctuations in construction activity.

In each trade, apprentices start at about 50 percent of the wage rate paid to experienced workers. The rate increases as they gain experience.

The work of bricklayers, stonemasons, and marble setters sometimes is strenuous because it involves moderately heavy lifting and prolonged standing and stooping. Most of the work is performed outdoors.

A large proportion of bricklayers, stonemasons, and marble setters are members of the Bricklayers, Masons and Plasterers' International Union of America.

Sources of Additional Information

For details about apprenticeships or other work opportunities in these trades, contact local bricklaying, stonemasonry, or marble setting contractors; a local of the union listed above; a local joint union-management apprenticeship committee; or the nearest office of the State employment service or State apprenticeship agency.

For general information about the work of either bricklayers or stonemasons, contact:

International Union of Bricklayers and Allied Craftsmen, International Masonry Apprenticeship Trust, 815 15th St. NW., Washington, D.C. 20005.

Information about the work of bricklayers also may be obtained from:

Associated General Contractors of America, Inc., 1957 E St. NW., Washington, D.C. 20006.

Brick Institute of America, 1750 Old Meadow Rd., McLean, Va. 22101.

CARPENTERS

(D.O.T. 860.281 through .781)

Nature of the Work

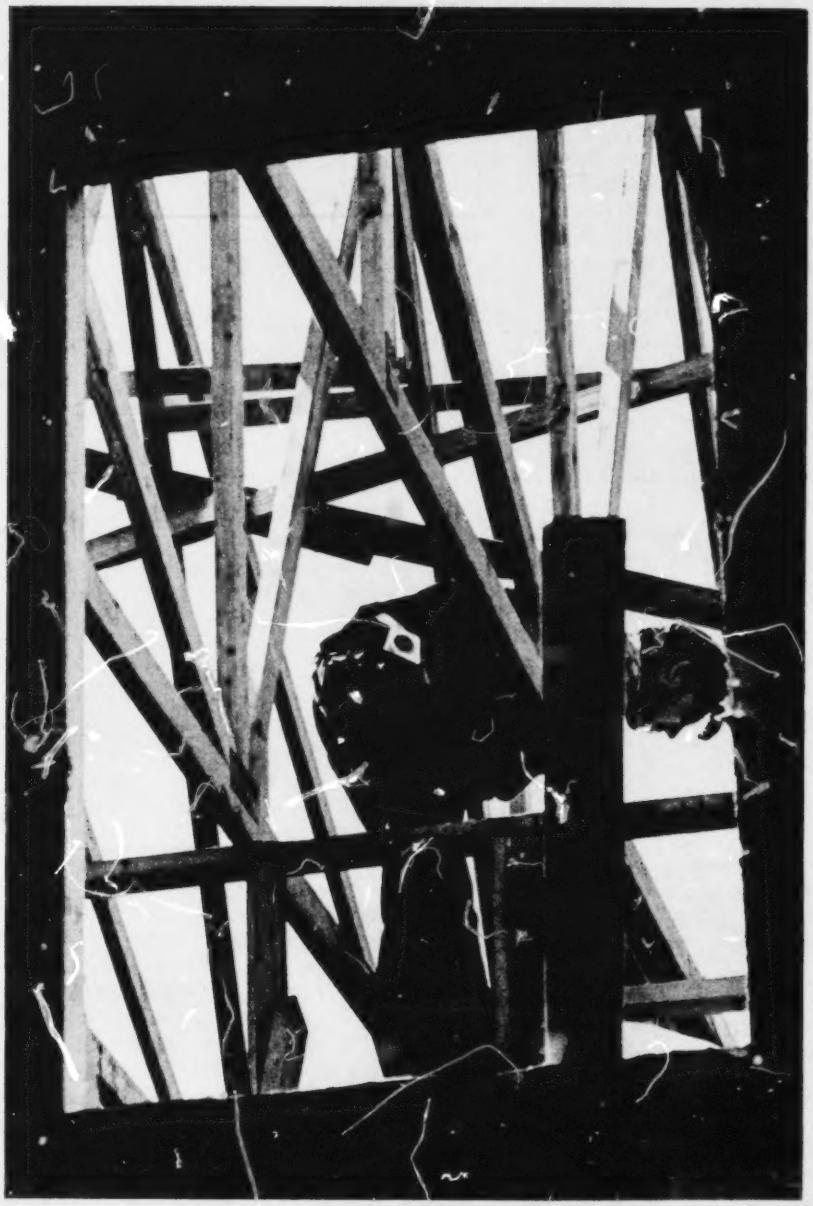
Carpenters, the largest group of building trades workers, are employed in almost every type of construction activity. Their work is commonly divided into two broad categories—"rough" carpentry and "finish" carpentry. Skilled carpenters are able to do both types of work.

Carpenters build according to instructions obtained from supervisors, blueprints, or both. In rough work, they erect the wood framework in buildings, including subfloors, partitions, floor joists, and rafters. In addition, they install heavy timbers used in the building of docks, railroad trestles, and similar heavy installations. Rough carpentry also includes the building of forms to enclose concrete until it is hardened, the making of chutes for pouring concrete, and the erecting of scaffolds and temporary buildings on the construction site. In all cases, carpenters must use materials and building techniques that conform to local building codes.

In finish work, which begins after the rough work is complete, carpenters install molding, wood paneling, cabinets, window sash, door frames, doors, and hardware and complete other finish work. Finish carpentry also includes building stairs and laying floors. Carpenters who do finish work must consider the appearance as well as the structural accuracy of the work. For example, they use a mitre-box saw to cut moldings so joints will not be noticed, and hide nails or screws with putty for a neat appearance.

As part of their job, carpenters also saw, fit, and assemble plywood, wallboard, and other materials. They use nails, bolts, wood screws, or glue to fasten materials. They may also install linoleum, asphalt tile, and similar soft floor coverings. Carpenters use handtools such as hammers, saws, chisels, planes, and power tools such as portable power saws, drills, and rivet guns.

Because of the wide scope of work in the trade, carpenters tend to concentrate on only one type of work. For example, some carpenters specialize in erecting new houses; others specialize in laying hardwood floors.



Over 1 million workers are employed as carpenters.

Specialization is more common in large metropolitan areas; in smaller communities and in rural areas, carpenters ordinarily do all types of carpentry and also may install glass, put in insulation, and paint.

Places of Employment

About 1,010,000 carpenters were employed in 1976, of whom about one in five was self-employed. Most carpenters work for contractors and homebuilders who construct new buildings and other structures or who alter, remodel, or repair buildings; some carpenters alternate between wage employment for contractors and self-employment on small jobs. Most other carpenters work for government agencies, utility companies, manufacturing firms, or other large organizations.

Carpenters work throughout the country and, because of their versatility, are much less concentrated geographically than any other construction occupation.

Training, Other Qualifications, and Advancement

Most training authorities recommend the completion of an apprenticeship program as the best way to learn carpentry. A large number of workers in this trade, however, have acquired their skills informally (for example, by working as carpenters' helpers).

The apprenticeship program, sponsored by the local joint committee of contractors and unions, usually consists of 4 years of on-the-job training, in addition to a minimum of 144 hours of related classroom instruction each year. On the job, apprentices learn elementary structural design and become familiar with the common systems of frame and concrete form construction. They also learn to use the tools, machines, equipment, and materials of the trade. In addition, they learn the many carpentry techniques, such as laying out, form building, framing, finishing, and welding.

Apprentices receive classroom instruction in drafting and blueprint reading, mathematics for layout work, and the use of woodworking machines. Both in the classroom and on the job they learn the relationship between carpentry and the other building trades, because the work of the carpenter is basic to the construction process.

Other informal on-the-job programs are provided by local contractors and usually are shorter and less thorough than apprenticeships. The degree of training and supervision in these programs depends principally on the size of the contractor. A small contractor who specializes in homebuilding may provide training in only one area—for example, rough framing. In contrast, a large general contractor may provide training in several areas.

Persons interested in carpentry should obtain the all-round training given in apprenticeship programs. Carpenters with such training will be in much greater demand and will have better opportunities for advancement than those who can do only the relatively simple, routine types of carpentry.

Apprenticeship applicants generally must be at least 17 years old. A high school or vocational school education is desirable, as are courses in carpentry, shop, mechanical drawing, and general mathematics. Good physical condition, a good sense of balance, and lack of fear of working on high structures are important assets. Applicants should also have manual dexterity and the ability to solve arithmetic problems quickly and accurately. In addition, they should be able to work closely with others. Required tests, designed to help measure an applicant's aptitude for carpentry, are given by local joint committees.

Carpenters may advance to carpenter supervisors or to general construction supervisors. Carpenters usually have greater opportunities than most other construction workers to become general construction supervisors since they are involved with the entire construction process. Some carpenters are able to become contractors and employ others.

Employment Outlook

Job opportunities for carpenters should be plentiful over the long run. Because of the large number of people employed in this field, replacement needs are high. Besides the job openings that result from the need to replace carpenters who retire, die, or leave their job for other reasons, many openings will be created by employment growth.

Employment of carpenters is expected to grow about as fast as the average for all occupations through the mid-1980's. Population and business growth will lead to a demand for more houses and other structures, thus increasing the demand for carpenters. More carpenters also will be needed for alteration and maintenance work. However, because construction activity is sensitive to ups and downs in the economy, the number of job openings may fluctuate greatly from year to year.

Earnings and Working Conditions

According to a survey of metropolitan areas in 1976, union wage rates for carpenters averaged $9.85 an hour, or about twice the average rate for production and nonsupervisory workers in private industry, except farming. Annual earnings, however, may not be as high as the hourly rates would indicate, because carpenters lose some worktime due to poor weather and occasional unemployment between jobs.

Hourly wage rates for apprentices usually start at about 50 percent of the rate paid to experienced carpenters and increase by about 5 percent at 6-month intervals.

As in other building trades, the carpenter's work is active and sometimes strenuous, but exceptional physical strength is not required. However, prolonged standing, as well as climbing and squatting, often are necessary. Carpenters risk injury from slips or falls, from contact with sharp or rough materials, and from the use of sharp tools and power equipment. Many people like carpentry because they can work outdoors.

A large proportion of carpenters are members of the United Brotherhood of Carpenters and Joiners of America.

Sources of Additional Information

For information about carpentry apprenticeships or other work opportunities in this trade, contact local carpentry contractors, a local of the union mentioned above, a local joint union-management apprenticeship committee, or the nearest office of the State employment service or State apprenticeship agency.

For general information on apprenticeship in this trade, contact:

Associated General Contractors of America, Inc., 1957 E St. NW., Washington, D.C. 20006.

United Brotherhood of Carpenters and Joiners of America, 101 Constitution Ave. NW., Washington, D.C. 20005.

CEMENT MASONS AND TERRAZZO WORKERS

(D.O.T. 844.884, 852 884, and 861.781)

Nature of the Work

Cement masons mix, pour, and finish concrete for many types of construction projects. The projects range from finishing of small jobs, such as patios and floors, to work on huge dams and miles of concrete highways. On small projects, a mason, assisted by one or two helpers, may do all of the masonry work; on large projects, a crew of several masons and many helpers may be employed. Among other tasks, cement masons may color concrete surfaces, expose aggregate in walls and sidewalks, or fabricate concrete beams, columns, and panels.

Terrazzo workers create attractive walkways, floors, patios, and panels by exposing marble chips and other fine aggregates on the surface of finished concrete. However, much of the preliminary work of terrazzo workers is the same as that for cement masons.

In preparing a site for pouring concrete, cement masons make sure the forms for molding the concrete are set for the desired pitch and depth and are properly aligned. Masons direct the pouring of the concrete and supervise laborers who use shovels or special rakes to place and spread the concrete. Masons then guide a "straightedge" (a long, straight piece of wood or similarly shaped piece of metal) back and forth across the top of the forms to level the freshly poured concrete and to show low spots, where concrete is added and leveled again.

Immediately after leveling the cement, masons carefully press a "darby" (a long, straight 1 inch by 4 inch piece of wood with smooth, rounded edges and a handle) with sweeping motions over the surface of the concrete, forcing heavy particles under and smoothing the top.

After darbying, masons wait until heavy particles in the cement settle to the bottom and excess water works its way to the surface. When the excess water evaporates and the concrete is firm but workable, masons complete their work.

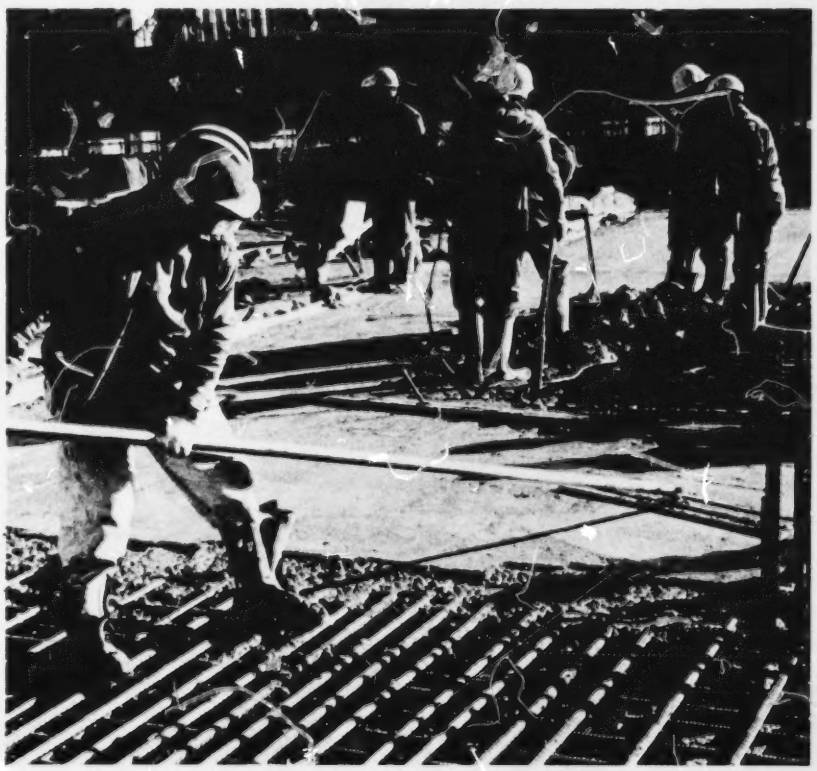
Finishers first press an edger gently between the forms and the concrete, and guide it carefully along the edge and the surface. This produces slightly rounded edges and helps prevent them from chipping or cracking.

For joints, finishers use a flat tool that has a smooth ridge protruding from the center. At specified markings, workers make joints or grooves that help prevent unsightly cracks on the surface.

Next, finishers rub a float—a small and smooth, rectangular piece of wood—over the entire surface, carefully avoiding edges and joints. Floating embeds the heavier material deeper into the concrete, removes most imperfections, and brings the lighter material—mortar—to the surface.

As the final step, masons sweep the mortar with a trowel (a flat, metal tool) back and forth over the surface to create a smooth finish. On some jobs, electrically powered trowels may be used.

Masons also produce other finishes. For a coarse, non-skid finish, ma-



Cement masons must know their materials and be familiar with various chemical additives that speed or slow the setting time.

sons brush the surface with a broom or stiff bristled brush. For a pebble-like finish, they embed gravel chips into the surface, leaving the tops of the chips exposed. They wash any excess cement from the exposed chips with a mild acid solution for a neat appearance. For color, they sprinkle on a dye which they brush and trowel into the surface.

For concrete surfaces, such as columns, ceilings, and wall panels, that will remain exposed after forms are stripped, concrete finishers locate and correct any defects. First, they chisel away high spots and loose cement and smooth them out with a rubbing brick. They then fill the defects with a rich cement mixture, and either float or trowel a smooth, uniform finish.

Some cement masons specialize in laying a mastic coat (a fine asphalt mixture) over concrete, particularly in buildings where sound-insulated or acid-resistant floors are specified.

Cement masons must know their materials and be familiar with various chemical additives which speed or slow the setting time. Because of the effects of heat, cold, and wind on the drying time of cement, masons must be able to recognize by sight and touch what is occurring in the cement mixture so that they can prevent structural defects.

Attractive, marble-chipped terrazzo requires three layers of materials. First, either cement masons or terrazzo workers build a solid, level concrete foundation that is 3 inches to 4 inches deep.

After the forms are removed from the foundation, workers apply a 1 inch deep mixture of sandy concrete. When this layer becomes tacky, terrazzo workers partially embed metal dividing strips into the concrete wherever there is to be a joint or change of color in the terrazzo. Before this layer dries, workers make sure the tops of the strips are level with one another. The ferrule strips become a network of rigid dividers for terrazzo panels, allowing for unique design and color variation between panels. They also help prevent cracks from developing in the finished terrazzo.

For the final layer, terrazzo workers blend a fine concrete mixture which may be color dyed. They pour this mixture into each of the panels, then hand trowel each panel until level with the tops of the ferrule strips. While the mixture is wet, workers toss marble chips of various colors into each of the panels. To completely embed the marble chips, workers roll a lightweight roller over the entire surface.

When the terrazzo is thoroughly dry, workers grind it with a terrazzo grinder(somewhat like a disc-type floor polisher, only much heavier). The surface is ground until even with the top of the ferrule strips. Pits and holes are filled and steel troweled for a smooth, level surface. When the surface is dry, terrazzo workers clean, polish, and seal it for a rich, lustrous finish.

Places of Employment

About 71,000 cement masons and terrazzo workers were employed in 1976. Cement masons work for general contractors who construct entire projects, such as highways or large buildings, and for contractors who do only concrete work. Some masons install composition resilient floors for specialty floor contractors. A small number of masons are employed by municipal public works departments, public utilities, and manufacturing firms that do their own construction work. Most terrazzo workers work for special trade contractors who install decorative floors and wall panels.

One out of 10 cement masons and terrazzo workers is self-employed, about the same proportion as in other building trades. Most masons specialize in small jobs, such as driveways, sidewalks, and patios; most terrazzo workers, in floors.

Training, Other Qualifications, and Advancement

Cement masons and terrazzo workers learn their trade either through on-the-job training as helpers or through 2-year or 3-year apprenticeship programs. About one-third of all cement masons worked as construction laborers before becoming cement masons.

On-the-job training programs, almost all of which are available to cement mason trainees, provide informal instruction from experienced workers. Helpers learn to handle the tools, equipment, machines, and materials of the trade. They begin with simple tasks, such as spreading and using a straightedge on freshly poured concrete. As they advance, assignments become more complex, and usually within a year helpers are doing finishing work.

Two-year and 3-year apprenticeship programs, usually sponsored by local union-contractor agreements, also provide on-the-job training in addition to 144 hours of classroom instruction each year. In the classroom, apprentices learn applied mathematics, blueprint reading, and safety. Three-year apprentices receive special instruction in layout work and estimating.

When hiring helpers and apprentices, employers prefer high school graduates who are at least 18 years old, in good physical condition, and licensed to drive. High school courses in shop mathematics and blueprint reading or mechanical drawing provide a helpful background.

Experienced cement masons or terrazzo workers may advance to supervisors or contract estimators, or may open concrete contracting businesses.

Employment Outlook

Employment of cement masons and terrazzo workers is expected to grow much faster than the average for all occupations through the mid-1980's. As population and the economy grow, more masons will be needed to help build apartments, offices, factories, and other structures. The greater use of concrete as a building material also will add to the demand for these workers. Prestressed concrete columns, for example, are being used increasingly in place of steel columns for large buildings. Besides the job openings created by employment growth, many openings will arise as experienced masons retire, die, or transfer to other fields of work. For terrazzo workers, most, if not all, openings will arise from replacement needs.

While the employment outlook is

expected to be favorable over the long run, the number of job openings may fluctuate from year to year because construction activity is sensitive to ups and downs in the economy.

Earnings and Working Conditions

Union cement masons and terrazzo workers in metropolitan areas had estimated average wages of $9.35 an hour in 1976, about twice the average wage for nonsupervisory and production workers in private industry, except farming. Union masons generally have higher wage rates than nonunion masons. Apprentices usually start at 50 to 60 percent of the rate paid to experienced cement masons or terrazzo workers.

Annual earnings for cement masons, terrazzo workers, and apprentices generally are lower than hourly rates would indicate because the annual number of hours they work can be adversely affected by poor weather and fluctuations in construction activity.

Cement masons usually receive premium pay for hours worked in excess of the regularly scheduled workday or workweek. They often work overtime, because once concrete has been poured the job must be completed.

Mason or terrazzo work is active and strenuous. Since most finishing is done on floors or at ground level, workers must stoop, bend, and kneel. Because some jobs are outdoors, worktime is lost due to rain and freezing weather. In some cases, however, concrete and terrazzo can be poured year round by using heated, temporary shelters made of sheet plastic.

A large proportion of cement masons and terrazzo workers are union members. They belong either to the Operative Plasterers' and Cement Masons' International Association of the United States and Canada, or to the Bricklayers, Masons and Plasterers' International Union of America.

Sources of Additional Information

For information about apprenticeships and work opportunities, contact local cement finishing contractors; locals of unions previously mentioned; a local joint union-management apprenticeship committee; or the nearest office of the State employment service or apprenticeship agency.

For general information about cement masons and terrazzo workers, contact:

Associated General Contractors of America, Inc., 1957 E St. NW., Washington, D.C. 20006.

International Union of Bricklayers and Allied Craftsmen, 815 15th St. NW., Washington, D.C. 20005.

Operative Plasterers' and Cement Mason International Association of the United States and Canada, 1125 17th St. NW., Washington, D.C. 20036.

CONSTRUCTION LABORERS

(D.O.T. 801.887, 809.887, 842.887, 844.887, 850.887, 851.887, 852.887, 853.887, 859.884 and .887, 860.884 and .887, 861.884 and .887, 862.884 and .887, 865.887, 866.887, 869.887, and 892.883)

Nature of the Work

Construction laborers work on all types of construction projects—houses, highways, dams, airports, missile sites. They are usually the first workers to arrive on a construction project—assisting in site preparation—and the last to leave. Laborers under the direction of other trade workers provide much of the routine physical labor on construction and demolition projects. They erect and dismantle scaffolding, set braces to support the sides of excavations, and clean up rubble and debris. Laborers also help unload and deliver materials, machinery, and equipment to carpenters, masons, and other construction workers.

On alteration and modernization jobs, laborers tear out the existing work. They perform most of the work done by wrecking and salvage crews during the demolition of buildings.

When concrete is mixed at the worksite, laborers unload and handle materials and fill mixers with ingredients. Whether the concrete is mixed on-site or hauled in by truck, laborers pour and spread the concrete and spade or vibrate it to prevent air pockets. In highway paving, laborers clean the right-of-way, grade and help prepare the site, and set the forms into which wet concrete is poured. They cover new pavement with straw, burlap, or other materials to keep it from drying too rapidly.

Some construction laborers have job titles that indicate the kinds of work they do. Bricklayers' tenders and plasterers' tenders, both commonly known as hod carriers, help bricklayers and plasterers by mixing and supplying materials, setting up and moving portable scaffolding, and providing many other services. Hod carriers must be familiar with the work of bricklayers and plasterers and know the materials and tools they use. Some hod carriers also help cement masons.

Another group of laborers, pipelayers, lay sewer and other large, nonmetal pipe and seal connections with concrete and other materials.

Recent years have seen much mechanization of the laborers' tasks. Thus, in their traditional work, laborers now may operate such things as

Recent years have seen much mechanization of the laborers' tasks.

motorized lifts and ditch-diggers of the "walk-behind" variety, various kinds of small mechanical hoists, as well as laser beam equipment to align and grade ditches and tunnels.

Although some construction laborers' jobs require few skills, many jobs require training and experience, as well as a broad knowledge of construction methods, materials, and operations. Rock blasting, rock drilling, and tunnel construction are examples of work in which "know-how" is important. Laborers who work with explosives drill holes in rock, handle explosives, and set charges. They must know the effects of different explosive charges under varying rock conditions to prevent injury and property damage. Laborers do almost all the work in the boring and mining of a tunnel, including operations that would be handled by workers in other trades if the job were located above ground.

Places of Employment

About 715,000 construction laborers were employed in 1976. Most of them worked for construction contractors, for State and city public works and highway departments, and for public utility companies.

Training, Other Qualifications, and Advancement

Little formal training is needed to get a job as a construction laborer. Generally, applicants must be at least 18 years old and in good physical condition. Most new employees transfer from other occupations, such as truckdriver, farm laborer, or janitor.

Beginners' jobs are usually of the simplest type, such as unloading trucks and digging ditches. As workers gain experience, job assignments become more complex.

Many tasks require skills too complex for on-the-job training. As a result, contractors and unions have established 4- to 8-week formal training programs in many States to teach basic construction concepts, safety practices, and machinery operation.

After several years of experience and training, many laborers advance to craft jobs, such as carpenter, bricklayer, or cement mason.

Employment Outlook

Employment of construction laborers is expected to grow about as fast as the average for all occupations through the mid-1980's. In addition to openings created by occupational growth, job openings will result from the need to replace workers who retire, die, or leave the occupation for other reasons. On the average, tens of thousands of job openings will become available each year. Because employment of laborers is sensitive to the ups and downs in construction activity, however, the annual number of openings may fluctuate.

Over the long run, growth in population and economic activity will spur construction. Laborers will be needed to meet the demand for moving materials, mixing and pouring concrete, and helping craft workers, particularly on large projects such as dams, highways, high rise buildings, and bridges.

Earnings and Working Conditions

Union wage rates for construction laborers averaged $7.50 an hour in 1976, compared with $4.87 an hour for production and nonsupervisory workers in private industry, except farming.

Annual earnings for construction laborers generally are lower than hourly rates would indicate because the annual number of hours they work can be adversely affected by poor weather and fluctuations in construction.

Construction work is physically strenuous, since it requires frequent bending, stooping, and heavy lifting. Much of the work is performed outdoors. Many construction laborers are members of the Laborers' International Union of North America.

Sources of Additional Information

For information about work opportunities, contact local building or construction contractors, a local of the Laborers' International Union of North America, or the local office of the State employment service.

For general information about the work of construction laborers, contact:

Laborers' International Union of North America, 905 16th St. NW., Washington, D.C. 20006.

Laborers'-Associated General Contractors' Education and Training Program, 1730 Rhode Island Ave., Suite 909, Washington, D.C. 20036.

ELEVATOR CONSTRUCTORS

(D.O.T. 825.381 and 829.281)

Nature of the Work

Elevator constructors, also called elevator mechanics, assemble and install elevators, escalators, and similar equipment. In new buildings, they install equipment during construction. In older buildings, they replace earlier installations with new equipment. Once the equipment is in service, they maintain and repair it. Installation or repair work usually is performed by small crews consisting of skilled elevator constructors and their helpers.

When installing a new elevator, mechanics first prepare the elevator shaft—a vertical opening that passes through the floors of a building and allows the elevator to move up and down. They remove any obstructions such as wood or metal crossmembers and, at the bottom of the shaft, they may erect forms, then mix and pour concrete for a foundation.

So the elevator will move up and down safely and smoothly, workers erect a strong steel frame within the shaft. For the frame, they bolt heavy steel guide rails to the walls along the shaft as well as to the steel supports fastened to the walls around the shaft at each floor.

To install electrical wires and controls, mechanics secure special metal tubing to the shaft's walls, running it from floor to floor. Workers then pull plastic-covered electrical wires through the tubing, which helps protect the wires. Next, they install cir-

cuit breakers and switches—usually at each floor and at the main control panel. Finally workers fasten the wires to the switches and test for proper connections.

Next, mechanics assemble the elevator car at the bottom of each shaft. "Footings" of the car frame are set into the grooves of the heavy steel guide rails; the frame parts are bolted or welded together. Workers then install the car's platform, walls, ceiling, and doors.

For each elevator, workers install a hoist. This giant, electrically powered spool simultaneously winds and unwinds a heavy steel cable that connects the elevator car at one end to its counterweight at the other. As a result, the car and its counterweight move in opposite directions to assist in each other's movement. While the hoist winds the cable from one side, pulling the car upward, it also unwinds the cable on the other side, causing the counterweight to descend. As the weight descends, it helps to pull the car swiftly and smoothly upward.

With the car assembled and the hoist installed, workers connect the necessary electrical wires to the car. These will carry signal instructions for the car's operation.

Next, at the elevator entrances on each floor, mechanics bolt metal door frames to the concrete, metal, or wood ceilings, floors, and walls. The frames support the grooved metal tracks along which the doors open and close. After setting the doors in the frames, workers connect and test the wires that help to operate the doors.

Finally, after the connections have been tested, the cables secured, and the guide rails greased, the entire system is checked for proper operation.

Elevator constructors employ similar work techniques when constructing escalators. These electrically powered stairs rotate around huge oval tracks that run from floor to floor. Unlike elevators, which run according to specific signals, escalators run continuously. Consequently, while elevators need sophisticated circuits and many wires, escalators only need one electric wire. Workers simply connect the wire from a switch to the motor that drives the giant bicycle-like chain and rotates the stairs.

Alteration work is similar to new installation because all elevator equipment except the old rail, car frame, platform, and counterweight is generally replaced. Elevator mechanics inspect elevator and escalator installations periodically and, when necessary, adjust cables and lubricate or replace parts.

Alteration work on elevators is important because of the rapid rate of innovation and improvement in elevator engineering.

To install and repair modern elevators, most of which are electrically controlled, elevator constructors must have a working knowledge of electricity, electronics, and hydraulics. They also must be able to repair electric motors as well as control and signal systems. Because of the variety of their work, they use many differ-

Growth in the number of high-rise buildings will increase demand for elevator constructors.

ent handtools, power tools, and testing meters and gauges.

Places of Employment

Most of the estimated 20,000 elevator constructors in 1976 were employed by elevator manufacturers to do installation, modernization, and repair work. Some are employed instead by small, local contractors who specialize in elevator maintenance and repair. Still others work for government agencies or business establishments that do their own elevator maintenance and repair.

Training, Other Qualifications, and Advancement

Almost all elevator constructors learn their skills through on-the-job training supplemented by classroom instruction. On the job, trainees are assigned initially to experienced elevator mechanics. Beginning tasks include carrying materials and tools, bolting rails to walls, and assembling cab parts. Eventually, tasks become more complex and require greater knowledge and skill. For example, electrical wiring requires a knowledge of local and national electrical codes and of electrical theory. Later on, trainees learn to test elevators and adjust them for maximum performance. In the classroom, trainees learn electrical and electronic theory, mathematics, applications of physics, and safety techniques.

Generally, training advancement depends upon the trainee's ability and level of experience. The average trainee usually qualifies as a helper after 6 months of experience and usually becomes a fully qualified elevator constructor within 4 years. Some States and cities require elevator constructors to pass a licensing examination.

Applicants for trainee positions must be at least 18 years old and have a high school or vocational school education, courses in electricity, mathematics, and physics can provide a useful background. Applicants also must pass an aptitude test before training begins. Good physical condition and a high degree of mechanical aptitude are important.

Some constructors advance to jobs as supervisors or elevator inspectors. A relatively small number go into the elevator contracting business.

Employment Outlook

Employment in this small occupation is expected to increase faster than the average for all occupations through the mid-1980's. Growth in the number of high-rise apartment and commercial buildings will create job openings in elevator construction, as will the need to replace experienced workers who retire, die, or stop working for other reasons. The total number of job openings will be limited, however, because of the relatively small size of the occupation.

Earnings and Working Conditions

In 1976, union elevator constructors in metropolitan areas had estimated average wages of $10.30 an hour or twice the average wage paid to production and nonsupervisory workers in private industry, except farming. Hourly wage rates for trainees start at about 50 percent of the rate paid to experienced elevator mechanics and increase periodically.

Unlike most other construction trades, elevator contructors usually work year round. When construction of new buildings declines, the construction of new elevators and escalators declines, but the demand for the repair and maintenance of older elevators and escalators increases.

Elevator construction involves lifting and carrying heavy equipment and parts, but this is usually done by helpers. Most of the work takes place indoors and at great heights. Workers are exposed to the dangers of falls and electrical shocks.

Most elevator constructors are members of the International Union of Elevator Constructors.

Sources of Additional Information

For further details about work opportunities as a helper in this trade, contact elevator manufacturers, elevator construction or maintenance firms, or a local of the union mentioned above. In addition, the local office of the State employment service may have information about opportunities in this trade.

For general information about the work of elevator constructors, contact:

International Union of Elevator Constructors, 5565 Sterrett Place, Clark Bldg., Suite 332, Columbia, Md. 21044.

IRONWORKERS

(D.O.T. 801.281, .381, .781, .884; 809.381, .781, .884; and 869.883)

Nature of the Work

Ironworkers erect steel framework and other metal parts in buildings, bridges, and other structures. They also rig heavy construction machinery (prepare it for moving) and deliver the machinery to new sites. In addition, ironworkers make alterations, such as installing steel stairs or adding window guards to buildings, and do repair work, such as replacing metal bridge parts.

Ironworkers comprise four related trades—structural ironworkers, riggers and machine movers, ornamental ironworkers, and reinforcing ironworkers. Many ironworkers are skilled in two of these trades or more.

Structural ironworkers (D.O.T. 809.381) erect, align, and fasten the steel framework of bridges, buildings, and other structures such as storage tanks. They also install floor decking and the doors and frames of bank vaults. Ironworkers follow blueprint specifications in erecting steel framework. They direct crane operators to hoist each steel part into proper position. Workers often push, pull, or pry beams and girders for last-second positioning before temporarily bolting them in place.

To permanently connect a steel member, ironworkers measure for correct alignment, using plumb bobs, levels, and measuring tapes. They remove temporary bolts if necessary, then jockey the steel beam or girder into position, using winches, hoists, and jacks. When the member is correctly aligned, workers bolt, rivet, or weld it to others for final fastening.

Ironworkers often work at great heights.

Riggers and machine movers (D.O.T. 869.883) set up and rig the hoisting equipment used to erect and dismantle structural steel frames. These skilled workers also move heavy construction machinery and equipment. They study the size, shape, and weight of the object to be moved, choose lines and cables to support its weight, and select points of attachment that will provide a safe and secure hold on the load. Next, they hook or bolt one or more cables to both the hoisting equipment and the item to be moved. Workers then direct the load into position by giving hand signals and other directions to the hoisting machine operator. In many instances, riggers build platforms or containers on the job to move unusually shaped materials and machines. This work requires a knowledge of hoisting equipment and lifting devices.

Ornamental ironworkers (D.O.T. 809.381) install metal stairways, catwalks, floor gratings, ladders, and window frames. They also install lampposts, fences, and decorative ironwork. In addition, they work with prefabricated aluminum, brass, and bronze items. Examples are recently developed ornamental building facades that are bolted or welded to a building.

Since other workers cut and shape most of the ornamental metal away from the construction site, ornamental ironworkers spend most of their time fitting, aligning, and assembling. On the job, workers make sure ornamental pieces fit correctly and hold firmly. Workers hacksaw oversized pieces to size and sometimes must drill holes. For secure connections, they rivet or weld the metals.

Reinforcing ironworkers (D.O.T. 801.884) set steel rods or bars in concrete forms to reinforce the concrete. They place the steel bars on suitable supports in the concrete form, then tie the bars together by wrapping and twisting wire around them. Workers follow supervisory instructions or blueprint specifications to make sure the reinforcing rods are positioned properly. Some concrete is reinforced with a coarse mesh made of welded wire. When using mesh, ironworkers measure the surface to be covered, cut and bend the mesh to the desired shape, and place it over the area to be reinforced. While a concrete crew pours the slab, ironworkers use hooked rods to position the wire mesh in the freshly poured mixture.

Places of Employment

About 71,000 structural and ornamental ironworkers were employed in 1976. Thousands of additional workers were employed as riggers, machine movers, and reinforcing ironworkers.

Most of these workers are employed by general contractors on large building projects, steel erection contractors, or ornamental iron contractors. Many are employed by large steel companies or their subsidiaries engaged in the construction of bridges, dams, and large buildings. Some work for government agencies, public utilities, or large industrial firms that do their own construction work. Very few are self-employed.

Ironworkers work in all parts of the country, but they are concentrated in metropolitan areas.

Training, Other Qualifications, and Advancement

Most training authorities recommend the completion of an apprenticeship as the best way to learn these trades. Some people, however, learn these trades informally by working as helpers to experienced ironworkers.

Apprenticeship programs, many of which are sponsored by local union-contractor agreements, usually consist of 3 years of on-the-job training and a minimum of 144 hours a year of classroom instruction in subjects such as drafting, blueprint reading, and mathematics applicable to layout work. Apprentices learn ornamental assembling, reinforcing, rigging, structural erecting, and welding.

Those who learn the trade informally usually start by moving materials—hauling rods and disposing of debris. Within a short period they can set reinforcing rods. Eventually, they do ornamental or structural work.

Applicants for apprenticeship or helper positions generally must be at least 18 years old and have a high school or vocational school education; courses in general mathematics and mechanical drawing provide a helpful background.

Since materials used in ironworking trades are heavy and bulky, above-average physical strength is necessary. Agility and a good sense of balance also are required in order to work at great heights and on narrow footings.

Experienced ironworkers can advance to supervisory positions. A small number go into the ironworking business.

Employment Outlook

Employment of ironworkers is expected to increase much faster than the average for all occupations through the mid-1980's. Growth in construction activity will increase the demand for these workers. Besides jobs resulting from employment growth, many openings will result from the need to replace experienced ironworkers who transfer to other fields of work, retire, or die. The number of job openings may fluctuate from year to year, however, because construction activity is sensitive to changes in the economy.

Employment in all ironworking occupations is expected to increase over the long run. The growing use of

structural steel in buildings will create a need for more structural ironworkers. Work opportunities for ornamental ironworkers will result from the growing popularity of ornamental panels for large buildings, and of metal frames to hold large glass installations. More riggers and machine movers will be needed to handle the increasing amount of heavy construction machinery. The growing demand for prestressed concrete will create additional job opportunities for reinforcing ironworkers.

Job openings for ironworkers usually are more abundant during the early spring when the weather warms up and the level of construction activity increases.

Earnings and Working Conditions

Union structural and reinforcing ironworkers in metropolitan areas earned estimated average wages of $10 an hour in 1976, or about twice the average wage of nonsupervisory and production workers in private industry, except farming. Apprentices start at 60 percent of the hourly rate paid to experienced workers. They receive increases as they gain experience. Annual earnings for these workers, however, are generally lower than hourly wages would indicate because the annual number of hours they work can be adversely affected by poor weather and fluctuations in construction activity.

Ironworkers often work at great heights, sometimes walking on mere 1 foot wide girders 20 floors or more above the ground. Although many of these workers risk injury from falls, safety devices such as nets, safety belts, and scaffolding have helped prevent accidents.

Ironwork can involve considerable travel because demand may be insufficient to keep local crews continually employed.

Many workers in these trades are members of the International Association of Bridge, Structural and Ornamental Iron Workers.

Sources of Additional Information

For more information on apprenticeships or other work opportunities, contact local general contractors; a local of the union mentioned above; a local joint union-management apprenticeship committee; or the nearest office of the State employment service or apprenticeship agency.

For general information about ironworkers, contact:

Associated General Contractors of America, Inc., 1957 E St. NW., Washington, D.C. 20006.

OPERATING ENGINEERS (CONSTRUCTION MACHINERY OPERATORS)

(D.O.T. 850.782 through .883, 851.782 and .883, 852.883, 853.782 and .883, and 859.782 and .883)

Nature of the Work

Lifting a quarter-ton pane of glass by crane and positioning it into an 8-foot by 10-foot window opening 10 stories above the ground requires considerable skill. At the crane's controls is an operating engineer. Operating engineers also work the controls of bulldozers, trench excavators, paving machines, and many other types of construction machinery. Some workers know how to operate several kinds of machines; others, only a few. Because the skills and training required vary, operating engineers usually are classified by either the type or the capacity of machines they operate.

Heavy machines are usually complex and difficult to operate. A large crane, for example, requires a high degree of skill. Operators must accurately judge distances and heights and push or pull a number of buttons, levers, and pedals in proper sequence while picking up and delivering materials. These controls rotate the crane, raise and lower its boom and loadline, or open and close attachments such as steel-toothed buckets for lifting dirt or clamps for lifting materials. At times, operators may not see either the pickup or delivery point and must follow the hand or flag signals of another worker.

Medium-sized equipment, on the other hand, usually requires less skill to operate. Bulldozer operators, for example, generally handle fewer controls than crane operators, and since the "dozer" operator works at ground level, estimating distances is less of a problem.

Operating a bulldozer is somewhat like driving a car and can be a relatively simple task. The huge "blade" attached to the front can be raised or lowered by pushing a button or by pushing or pulling a lever. To clear land, a bulldozer operator simply lowers the blade to the ground, shifts to forward gear and presses a pedal for power, causing the blade to scrape and level the ground. The operator will back up and repeat the process until the land is cleared.

Of the three weight classifications, light equipment such as an air compressor is the easiest to operate and, therefore, requires the least skill.

Before starting an air compressor (a diesel engine that takes in air and forces it through a narrow hose), the operator checks for tight hose connections and may manually pump air through the compressor to check for leaks. The operator also makes sure the compressor has fuel and water. The operator then starts the air compressor and allows it to build sufficient pressure to run special "air" tools. While the compressor is running, the operator periodically checks fuel, water, and pressure levels. At the end of the work day, the operator turns the compressor off and "bleeds-off" pressure in the air hose by opening an air pressure release valve. This allows for easy engine starting the next time it is to be used.

Operating engineer helpers, sometimes called "oilers," make sure the machines have gas and oil and are properly lubricated. Helpers also make minor repairs and adjustments. Experienced operators who are working alone also perform these tasks. Major repairs, however, usually are made by heavy-equipment mechanics.

Places of Employment

Approximately 600,000 operating engineers were employed in 1976.

An estimated 290,000 operated excavating, grading, and road machinery; about 130,000 worked as bulldozer operators; and nearly 165,000 operated other construction machinery, including cranes, derricks, hoists, air compressors, trench-pipe layers, and dredges.

Most operating engineers work for contractors in highway, dam, airport, and other large-scale construction projects. Others work for utility companies, manufacturers, and other business firms that do their own construction work, as well as State and local highway and public works departments. Some operating engineers are employed in factories and mines to operate cranes, hoists, and other power-driven machinery. Less than one-tenth of all operating engineers are self-employed, a smaller proportion than in most building trades.

Operating engineers are employed in every section of the country, both in large cities and in small towns. Some work on highways and dams being built in remote locations.

Training, Other Qualifications, and Advancement

Although in years past, some operating engineers have learned their skills on the job without formal instruction, employers today prefer individuals with some formal training. Most training authorities recommend completion of a 3-year formal apprenticeship as the best way to become an operating engineer. Since apprentices learn to operate a variety of machines, they have better job opportunities. Less extensive training is available through special heavy-equipment training schools.

The apprenticeship program, usually sponsored through a union-management committee but also available in the Armed Forces, consists of at least 3 years of on-the-job training, as well as 144 hours a year of related classroom instruction.

Under the supervision of experienced operating engineers, apprentices work as oilers or as helpers. Initial tasks include cleaning, greasing, repairing, and starting machines. Within a year, apprentices usually are given the opportunity to perform simple machine operations, such as light lifts with a crane. In time, they receive less supervision and more responsibility. In the classroom, apprentices receive instruction in engine operation and repair, cable splicing, hydraulics, welding, and safety and first aid.

A number of private schools offer instruction in the operation of certain types of construction equipment. Persons considering enrolling in any school, whether public or private, that offers training for an operating engineer career should contact construction employers in their area to determine the school's performance in producing suitably trained candidates.

For apprentice jobs, employers prefer to hire high school or vocational school graduates who are at least 18 years old. Courses in driver education and automobile mechanics provide a helpful background. Experience in operating tractors and other farm machinery also is helpful.

Operating engineers who have leadership ability may become supervisors, but opportunities are few. Some operating engineers start their own excavating and grading business.

Employment Outlook

Job opportunities for operating engineers should be fairly plentiful over the long run. Employment in this occupation is expected to grow faster than the average for all occupations through the mid-1980's. Population and business growth will lead to the construction of more factories, mass transit systems, office buildings, powerplants, and other structures, thereby increasing the demand for operating engineers. More operating engineers also will be needed in other areas, such as maintenance on highways and materials movement in factories and mines.

Besides the job openings created by employment growth, many openings will arise as experienced operating engineers retire, die, or leave the occupation for other reasons. Jobs should be easiest to find during spring and summer since construction picks up as the weather becomes warmer. However, because construction activity is sensitive to ups and downs in the economy, the number of job openings may fluctuate from year to year.

Earnings and Working Conditions

Wage rates for operating engineers vary according to the machine operated. According to 1976 estimates of union wages in metropolitan areas,

Operating engineers must judge distances accurately and handle controls precisely.

hourly rates for crane operators averaged $9.90; for bulldozer operators, $9.55; and for air compressor operators, $8.65. These rates are about twice as much as the average for all nonsupervisory and production workers in private industry, except farming. Annual earnings, however, generally are lower than hourly wage rates would indicate because the annual number of hours worked can be adversely affected by poor weather and fluctuations in construction activity. Hourly wage rates for apprentices start at about 70 percent of the full rate paid to experienced workers and increase periodically.

Operating engineers work outdoors; consequently, they usually work steadily during the warmer months and experience slow periods during the colder months. Time also may be lost due to rain or snow. Operating some machines, particularly bulldozers and some types of scrapers, is physically tiring because the constant movement of the machine shakes or jolts operators and may subject them to high noise levels.

Many operating engineers are members of the International Union of Operating Engineers.

Sources of Additional Information

For further information about apprenticeships or work opportunities in this occupation, contact a local of the International Union of Operating Engineers; a local joint apprenticeship committee; or the nearest office of the State apprenticeship agency. In addition, the local office of the State employment service may provide information about apprenticeship and other programs that provide training opportunities.

For general information about the work of operating engineers, contact:

Associated General Contractors of America, Inc., 1957 E St. NW., Washington, D.C. 20006.

International Union of Operating Engineers 1125 17th St. NW., Washington, D.C. 20036.

PLUMBERS AND PIPEFITTERS

(D.O.T. 862.381)

Nature of the Work

Plumbers and pipefitters install pipe systems that carry water, steam, air, or other liquids or gases. They also alter and repair existing pipe systems and install plumbing fixtures, appliances, and heating and refrigeration units.

Although plumbing and pipefitting are sometimes considered a single trade, workers can specialize in either craft. Plumbers install water, gas, and waste disposal systems in homes, schools, factories, and other buildings. Pipefitters, on the other hand, install both high- and low-pressure pipes that carry hot water, steam, and other liquids and gases for use in industrial processes. For example, pipefitters install the complex pipe systems in oil refineries and chemical processing plants.

In each of these trades, installation techniques are similar because they all involve pipes, faucets, and valves, and problems encountered in one trade are similar to those in another.

Most pipes are copper, cast iron, or some other metal; others may be plastic, glass, or other non-metallic material. While some iron pipes come ready to install, other metal or plastic pipes may have to be "fitted" for the job. To fit pipes, workers may have to measure, bend, cut, and thread pipes, then bolt, braze, glue, screw, solder, or weld them together.

For exacting cuts, workers use a pipecutter. This tool has a long handle and two very sharp, 1- to 2-inch, steel-cutting wheels. Workers separate the wheels' edges, set the pipe between them, then tighten the wheels against the pipe. Tightening causes the sharp edges of the wheels to cut just into the pipe's surface on opposite sides. Using the handle for leverage, workers rotate the tool, causing the steel wheels to cut a groove in an exact line around the pipe. To cut entirely through the pipe, workers repeatedly tighten the wheels and rotate the tool around the pipe.

To prepare pipes that will be screwed together, workers sometimes must thread pipes. Threads are the grooves that spiral around the ends of pipes either on the outside or the inside.

Workers thread pipes with a pipethreader, a tool similar to the pipecutter. The pipethreader has one or more steel cutting dies (like rows of teeth) pitched at an angle. Workers fasten this tool to the end of a pipe. As they rotate the threader around the pipe, the dies' pitched angle and sharp edges cause the threader to move along as it shaves a groove around the pipe.

Workers also may bend pipes to fit around obstructions. To bend a pipe, workers fasten it securely within a bending device at or near the point of the intended bend, then apply pressure to one end of the pipe.

When the pipes and other pieces are ready, workers install and connect them according to the instructions on blueprints. They may have to drill holes in ceilings, floors, and walls, or hang steel supports from ceilings to position the pipes properly.

After setting the pipes in place, workers connect them. They insert the end of a pipe into the slightly larger end of a valve or properly shaped connector. Workers then may use wrenches to screw threaded pipes tightly together, or may glue, solder, or weld connections to prevent leaks. To connect large pipes, such as those in buildings or industrial plants, workers bolt together the raised collars on the ends of pipes and valves.

Some plumbers and pipefitters specialize in gas, steam, or sprinkler fitting. Gasfitters install and maintain the fittings and extensions that connect gasline mains with the lines leading to homes. Steamfitters assemble and install steam or hot water systems for commercial and industrial uses. Sprinkler fitters install and maintain the piping for fire extinguishing systems.

Plumbers and pipefitters use wrenches, reamers, drills, braces and bits, hammers, chisels, saws, and other handtools. Power machines often

are used to cut, bend, and thread pipes. Hand-operated hydraulic pipe benders also are used. In addition, plumbers and pipefitters use gas or acetylene torches and welding, soldering, and brazing equipment.

Places of Employment

Most plumbers and pipefitters—who numbered about 385,000 in 1976—work for plumbing and pipefitting contractors engaged in new construction activity, and work mainly at the construction site. A substantial proportion of plumbers are self-employed or work for plumbing contractors doing repair, alteration, or modernization work. Some plumbers install and maintain pipe systems for government agencies and public utilities, and some work on the construction of ships and aircraft. Others do maintenance work in industrial and commercial buildings. Pipefitters, in particular, are employed as maintenance personnel in the petroleum, chemical, and food-processing industries where manufacturing operations include the processing of liquids and gases through pipes.

Training, Other Qualifications, and Advancement

Apprenticeship is the best way for plumbers or pipefitters to learn all aspects of these trades. A large number of people, however, learn plumbing and pipefitting by working for several years as helpers to experienced plumbers and pipefitters, and observing and receiving instruction from them.

Most apprenticeship programs for plumbers and pipefitters are sponsored through union-management agreements and usually consist of 5 years of on-the-job training, in addition to at least 216 hours annually of related classroom instruction. Subjects include drafting and blueprint reading, mathematics applicable to layout work, applied physics and chemistry, and local building codes and regulations.

On the job, helpers and apprentices begin with simple tasks such as carrying materials and cleaning up debris. In a short time they learn to measure and cut pipe, and later to bend, thread, and connect it. The most difficult form of connecting pipe is welding. This is taught toward the end of training. In the final phase of training, helpers and apprentices may learn to estimate costs.

Applicants for apprentice or helper jobs generally are required to be at least 16 years old and in good physical condition. A high school or vocational school education generally is recommended. Courses in chemistry, general mathematics, mechanical drawing, physics, and shop are helpful. Applicants may be given tests to determine whether they have the mechanical aptitude required in these trades. To obtain a plumber's or pipefitter's license, which some communities require, individuals must pass a special examination to demonstrate knowledge of the trade and of the local plumbing codes.

Some plumbers and pipefitters may become supervisors for plumbing and pipefitting contractors. Many go into business for themselves. As they expand their activities, they may employ other workers and become contractors. In most localities, contractors are required to obtain a master plumber's license.

Employment Outlook

Employment of plumbers and pipefitters is expected to grow faster than the average for all occupations through the mid-1980's. Thousands of job openings are expected because of employment growth and the need to replace plumbers and pipefitters who retire, die, or stop working for other reasons.

Employment is expected to grow mainly as a result of the anticipated increase in construction activity. Furthermore, plumbing will become more important in many types of construction. For example, a larger proportion of homes will have air-conditioning equipment, solar heating devices, and appliances such as washing machines and kitchen waste-disposal equipment. Chemical and petroleum refineries and coal gasification and nuclear powerplants, which use pipe extensively in their processing activities, are expected to expand, thus creating additional jobs for plumbers and pipefitters. Maintenance, repair, and modernization of existing plumbing or piping systems also will create employment opportunities.

Plumbing is one of the highest paying building trades.

Employment growth is expected to be fairly steady in the years ahead since plumbing and pipefitting are less sensitive to ups and downs in construction activity than are most other building trades.

Earnings and Working Conditions

According to a survey of metropolitan areas, union wage rates for plumbers and for pipefitters in 1976 averaged $10.40 an hour, or about twice the average wage for nonsupervisory and production workers in private industry, except farming. Apprentice wage rates start at 40 to 50 percent of the rate paid to experienced plumbers or pipefitters and increase as they gain experience. Annual earnings of workers in these fields are among the highest in the building trades because plumbing and pipefitting are affected less by bad weather and fluctuations in construction activity than are most other building trades.

Plumbing and pipefitting work is active and sometimes strenuous. These workers frequently must stand for long periods and occasionally work in cramped or uncomfortable positions. They risk the danger of falls from ladders, cuts from sharp tools, and burns from hot pipes. The injury rate for employees of plumbing, heating, and air-conditioning contractors in the construction industry has been about the same as the average for contract construction as a whole, but higher than the average for manufacturing.

Many plumbers and pipefitters are members of the United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada. Some plumbers and pipefitters who are contractors are members of the National Association of Plumbing-Heating-Cooling Contractors.

Sources of Additional Information

For information about apprenticeships or work opportunities in these trades, contact local plumbing, heating, and air-conditioning contractors; a local of the union mentioned above; a local joint union-management apprenticeship committee; or the nearest office of the State employment service or State apprenticeship agency.

For general information about the work of plumbers, pipefitters, and sprinkler fitters, contact:

National Association of Plumbing-Heating-Cooling Contractors, 1016 20th St. NW., Washington, D.C. 20036.

National Automatic Sprinkler and Fire Control Association, P.O. Box 719, Mt. Kisco, N.Y. 10549.

United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada, 901 Massachusetts Ave. NW., Washington, D.C. 20001.

ROOFERS

(D.O.T. 804.281, 843.844, and 866.381)

Nature of the Work

A leaky roof can cause damage to ceilings, walls, and furnishings. To keep out water, roofers apply materials such as asphalt, felt, shingles, slate, and tile to the roofs of buildings. These workers also waterproof walls and floors.

Roofers work with various kinds of roofing. To apply composition roofing, such as tar-and-gravel, roofers first measure, cut, and place strips of tarred felt over the entire surface. Next, they pour hot tar from a bucket and mop the tar over the felt and seams to seal them and make the surface watertight. They repeat the first two steps to build up the thickness of the tar. For the last coat, they use a broom like device to spread a hot mixture of thick tar over the surface. Finally, they add gravel, which sticks firmly to the tar.

When applying asphalt shingles, another type of composition roofing, roofers first lay, cut, and tack three-foot strips of roofing felt lengthwise over the entire roof. Then, starting from the bottom edge, they overlap and nail succeeding rows of asphalt shingles. Workers measure and cut the felt and shingles to fit around corners, pipes, and chimneys. Wherever two roof surfaces intersect, roofers cement or nail flashing (strips of felt or metal) over the joints to make them watertight.

A roofer's work may be especially hot during summer.

Roofers also use metal, tile, and slate. They build metal roofs by soldering together metal sheets and nailing them over the wood sheathing. To install tile and slate roofs, they place a covering of felt over the wood sheathing, punch holes in the slate or tile, and nail it to the sheathing. Each row of slate or tile overlaps the preceding row. Finally, roofers cover exposed nailheads with cement to prevent rust and water leakage. They use handtools such as hammers, roofing knives, mops, and calking guns.

Some roofers also waterproof and dampproof masonry and concrete walls and floors. To prepare surfaces for waterproofing, they hammer and chisel away rough spots or remove them with a rubbing brick before brushing on a coat of liquid waterproofing compound. They also may paint or spray surfaces with a waterproofing material or nail waterproofing fabric to surfaces. When dampproofing, they usually spray a coating of tar or asphalt on interior or exterior surfaces.

Places of Employment

About 90,000 roofers were employed in 1976. Most worked for roofing contractors on construction or repair jobs. Some worked for businesses and government agencies that do their own construction and repair work. A few roofers were self-employed.

Training, Other Qualifications, and Advancement

A 3-year apprenticeship program—usually sponsored by a local union-management committee—generally provides the most thorough training for this trade. However, the majority of roofers acquire their skills informally by working as helpers for experienced roofers.

Helpers learn the trade on the job. They start by carrying equipment and material and by erecting scaffolds. Within 2 or 3 months they are taught to measure, cut, and fit roofing materials such as felt. Soon, they are able to lay asphalt shingles. After a year or so, they learn to lay and fit tile, and eventually slate. Whether or not helpers learn to dampproof or waterproof depends upon the employer.

The apprenticeship program generally consists of a minimum of 1,400 hours of on-the-job training annually, in addition to 144 hours of classroom instruction in subjects such as blueprint reading, mathematics, and safety. On-the-job training for apprentices is similar to that for helpers, except that the apprenticeship program is broader and more structured. For example, apprentices work on specific areas of roofing for specified periods. They also learn to dampproof and waterproof.

For those interested in becoming roofers, a high school education or its equivalent is helpful, as are courses in mechancial drawing and basic mathematics. Good physical condition and a good sense of balance also are important assets. Applicants for apprenticeship programs must be at least 18 years old.

Roofers may advance to supervisor or to superintendent for a roofing contractor. Also, they may enter business for themselves and hire other roofers.

Employment Outlook

Employment of roofers is expected to increase faster than the average for all occupations through the mid-1980's. More roofers will be needed due to the longrun increase in construction activity. New construction and repairs on existing roofs will provide most of the work opportunities. Dampproofing and waterproofing, however, will provide an increasing proportion of roofers' work. Besides the job openings resulting from employment growth, some openings will arise from the need to replace experienced roofers who retire, die, or stop working for other reasons. Because construction activity fluctuates, however, job openings may be plentiful in some years, scarce in others. Jobs should be easiest to find during spring and summer since roofing work picks up as the weather becomes warmer.

Earnings and Working Conditions

In 1976, union roofers in metropolitan areas had estimated average wages of $9.30 an hour, or about twice the average hourly rate paid to nonsupervisory or production workers in private industry, except farming. Yearly earnings for roofers and apprentices, however, generally are lower than hourly rates would indicate because the annual number of hours they work can be adversely affected by poor weather and fluctuations in construction activity.

Apprentices usually start at 65 percent of the skilled roofer's pay rate and receive increases periodically.

Roofers' work is sometimes strenuous. It involves a lot of standing, as well as climbing, bending, and squatting. Roofers risk injuries from slips or falls from scaffolds or roofs, and may have to be outdoors in all types of weather, particularly when making repairs. The work may be especially hot during the summer months.

Many roofers are members of the United Slate, Tile and Composition Roofers, Damp and Waterproof Workers Association.

Sources of Additional Information

For information about roofing apprenticeships or work opportunities in this trade, contact local roofing contractors; a local of the union previously mentioned; a local joint union-management apprenticeship committee; or the nearest office of the State employment service or State apprenticeship agency.

For information about the work of roofers, contact:

National Roofing Contractors Association, 1515 N. Harlem Ave., Oak Park, Ill. 60302.

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What to Look For in this Reprint

To make the *Occupational Outlook Handbook* easier to use, each occupation or industry follows the same outline. Separate sections describe basic elements, such as work on the job, education and training needed, and salaries or wages. Some sections will be more useful if you know how to interpret the information as explained below.

The TRAINING, OTHER QUALIFICATIONS, AND ADVANCEMENT section indicates the preferred way to enter each occupation and alternative ways to obtain training. Read this section carefully because early planning makes many fields easier to enter. Also, the level at which you enter and the speed with which you advance often depend on your training. If you are a student, you may want to consider taking those courses thought useful for the occupations which interest you.

Besides training, you may need a State license or certificate. The training section indicates which occupations generally require these. Check requirements in the State where you plan to work because State regulations vary.

Whether an occupation suits your personality is another important area to explore. For some, you may have to make responsible decisions in a highly competitive atmosphere. For others, you may do only routine tasks under close supervision. To work successfully in a particular job, you may have to do one or more of the following:

- motivate others
- direct and supervise others
- work with all types of people
- work with things—you need good coordination and manual dexterity
- work independently—you need initiative and self-discipline
- work as part of a team
- work with details, perhaps numbers or laboratory reports
- help people
- use creative talents and ideas
- work in a confined area
- do physically hard or dangerous work
- work outside in all types of weather

A counselor can help you find out more about your interests and abilities so you can judge whether a job's characteristics suit you.

The EMPLOYMENT OUTLOOK section tells whether or not the job market is likely to be favorable. Usually an occupation's expected growth is compared to the average projected growth rate for all occupations (20.1 percent between 1976 and 1985). The following phrases are used:

Much faster	50% or more
Faster	25.0 to 49.9%
About as fast	15.0 to 24.9%
Slower	4.0 to 14.9%
Little change	3.9 to -3.9%
Decline	-4.0% or more

Generally, job opportunities are favorable if employment is growing at least as fast as for the economy as a whole.

But, you would have to know the number of people competing with you to be sure of your prospects. Unfortunately, this supply information is lacking for most occupations.

There are exceptions, however, especially among professional occupations. Nearly everyone who earns a medical degree, for example, becomes a practicing physician. When the number of people pursuing relevant types of education and training and then entering the field can be compared with the demand, the outlook section indicates the supply/demand relationship as follows:

Excellent	Demand much greater than supply
Very good	Demand greater than supply
Good or favorable	Rough balance between demand and supply
May face competition	Likelihood of more supply than demand
Keen competition	Supply greater than demand

Competition or few job openings should not stop your pursuing a career that matches your aptitudes and interests. Even small or overcrowded occupations provide some jobs. So do those in which employment is growing very slowly or declining

Growth in an occupation is not the only source of job openings because the number of openings from turnover can be substantial in large occupations. In fact, replacement needs are expected to create 70 percent of all openings between 1976 and 1985.

Finally, job prospects in your area may differ from those in the Nation as a whole. Your State employment service can furnish local information.

The EARNINGS section tells what workers were earning in 1976.

Which jobs pay the most is a hard question to answer because good information is available for only one type of earnings—wages and salaries—and not even this for all occupations. Although 9 out of 10 workers receive this form of income, many earn extra money by working overtime, night shifts, or irregular schedules. In some occupations, workers also receive tips or commissions based on sales or service. Some factory workers are paid a piece rate—an extra payment for each item they make.

The remaining 10 percent of all workers—the self-employed—includes people in many occupations—physicians, barbers, writers, and farmers, for example. Earnings for self-employed workers even in the same occupation differ widely because much depends on whether one is just starting out or has an established business.

Most wage and salary workers receive fringe benefits, such as paid vacations, holidays, and sick leave.

Workers also receive income in goods and services (payment in kind). Sales workers in department stores, for example, often receive discounts on merchandise.

Despite difficulties in determining exactly what people earn on the job, the Earnings section does compare occupational earnings by indicating whether a certain job pays more or less than the average for all nonsupervisors in private industry, excluding farming.

Each occupation has many pay levels. Beginners almost always earn less than workers who have been on the job for some time. Earnings also vary by geographic location but cities that offer the highest earnings often are those where living costs are most expensive.

What's an ad for the OOQ doing in a place like this?

The career information contained in the reprint you are reading was taken from the 1978-79 edition of the Occupational Outlook Handbook. But the Handbook is not the only source of useful career information published by the Bureau of Labor Statistics. The Handbook's companion, the Occupational Outlook Quarterly, is published four times during the school year to keep subscribers up to date on new occupational studies completed between editions of the Handbook. The Quarterly also gives practical information on training and educational opportunities, salary trends, and new and emerging jobs—just what people need to know to plan careers.

If you were a subscriber to recent issues of the Occupational Outlook Quarterly, you could have learned

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